ISOETACEAE

Isoetes Engelmannii var.
caroliniana A. A. Eaton Western

I wish to acknowledge with thanks my obligations to Professor E. H. Hall, of the North Carolina College for Women, for the specimens he has donated to me; to Dr. Maxon and his associates for confirming some of the identifications and making others, and to Dr. Pfeiffer for identifying the Isoetes.

DUKE UNIVERSITY, DURHAM, N. C.

Studies of Equiseta in European Herbaria*

JOHN H. SCHAFFNER

Various problems in relation to certain species of Equisetum had presented themselves to the writer which he was not able to solve with the inadequate material in American herbaria. The summer of 1930 was, therefore, spent in Europe in studying herbarium material and the opportunity was also afforded of attending the Fifth International Botanical Congress at Cambridge, England, August 16–23. The investigations were made at the following herbaria where a large number of records on the geographic distribution of all the species was also obtained: The Amsterdam Botanic Garden, the Berlin Botanic Garden, the Basel Botanic Garden, the Zürich Botanic Garden, the Herbier Boissier of the University of Geneva, the Herbier Delessert of the Geneva Botanic Garden, the Herbarium of Cambridge University, the herbarium of the British Museum of Natural History, London, the Linnean Herbarium owned by the

---

* Papers from the Department of Botany, the Ohio State University, No. 000.

Linnean Society of London, and the Kew Herbarium at the Kew Royal Botanic Garden. The writer is under great obligations to the Directors, Curators, and Keepers at all of these institutions and desires hereby to express his sincere thanks for the many courtesies shown and for much kindly assistance given to further his studies, which had to be made rather hurriedly because of limited time.

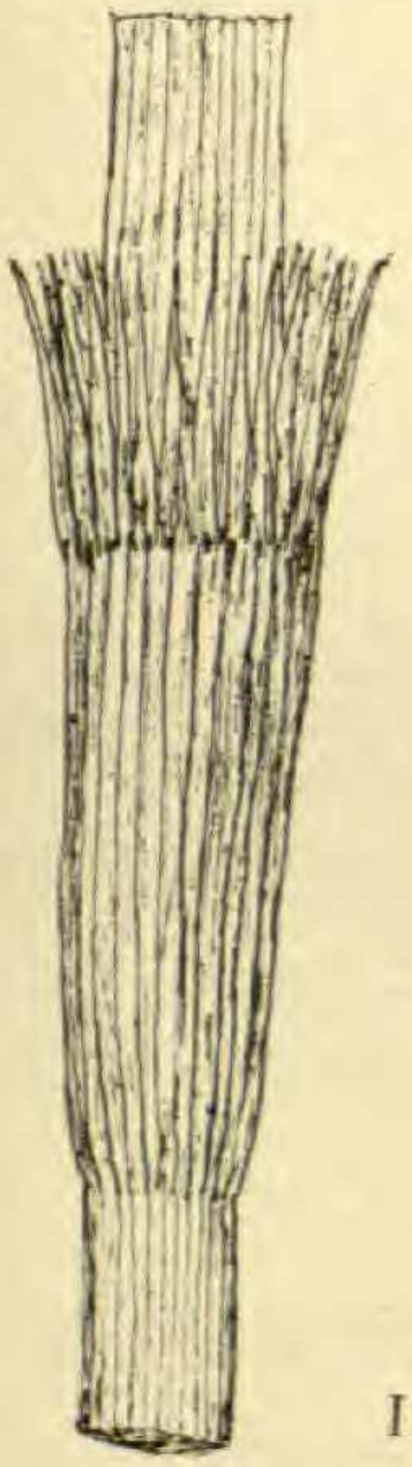
The deductions given below are based on the writer's own determination on good material. In all herbaria there has been much confusion in determinations and names. *Equisetum moorei* is sometimes confused with *E. trachyodon, E. diffusum* with *E. arvense, E. arvense* with *E. telmateia. E. trachyodon* is sometimes labeled *E. hiemale schleicheri,* sometimes *E. hiemale doellii,* etc. Under the name *E. laevigatum* were found not only the true *E. laevigatum* but also perfect specimens of *E. praealtum, E. fluviatile,* and *E. kansanum.* A specimen of *E. trachyodon* from Vancouver Island with long cylindrical, black, crusty sheaths, short persistent teeth, and other characters peculiar to this species, was labeled *E. ramosissimum* and has frequently been quoted as such in distribution records. The whole Equisetum problem has also been greatly confused by a ridiculous multiplication of varietal names which in most cases at least represent nothing but ordinary fluctuations. Sometimes these "varieties" do not even belong to the species to which they are attached. A beginner then must necessarily be greatly confused if he attempts to draw conclusions from the usual herbarium material both in America and Europe.

EQUISETUM RAMOSISSIMUM DESF. AND EQUISETUM DEBILE ROXB.

In general, *E. ramosissimum* extends from the Azores and the British Isles to Japan and through eastern

Africa to Cape Colony, while *E. debile* extends from northern India and Ceylon through the East Indies to the Fiji Islands. Baker considered the species as doubtfully distinct and an attempt was, therefore, made to discover distinguishing characters if such were present. Although a supposed distinction is sometimes based on the sheath segments as rounded in *E. ramosissimum* and flattened with angular sides in *E. debile* this seems of no importance. An important difference was found in the comparative lengths of the sheaths of large shoots. The sheaths of *E. ramosissimum* are usually twice as long or more as those of *E. debile.* In the latter species the sheaths are usually about as long as broad in the large shoots. It is easy to separate the two species by this character if ideal specimens are in hand (Figs. 1, 2). but smaller specimens of *E. ramosissimum* show no such distinction (Fig. 3). Apparently there are two distinct hereditary types but their fluctuations are so extreme that they overlap completely. *E. debile* seems to be the only form in southeastern Asia and the East Indies while *E. ramosissimum* is represented in the rest of Asia, Europe, and Africa. On the geographic transition it seems impossible to tell imperfect specimens apart, so there is nothing left to do but to draw the geographic line and name the specimens accordingly.

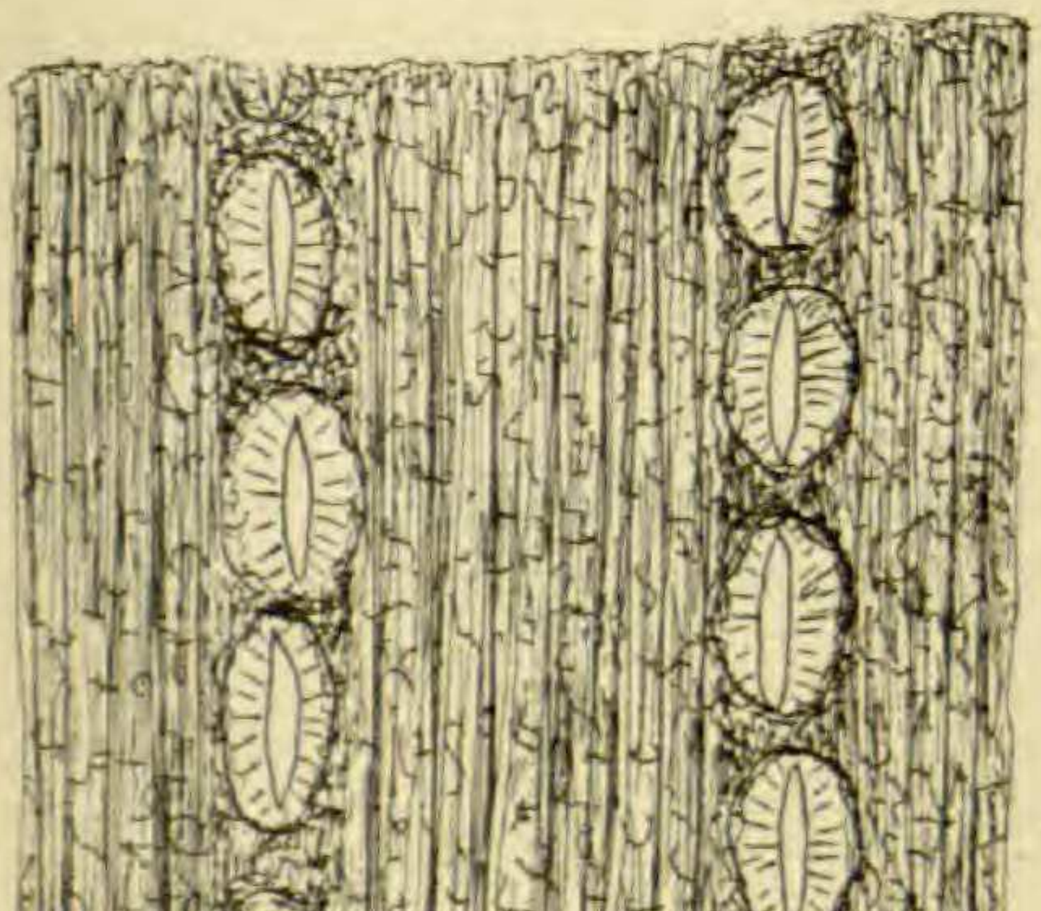
Without the teeth, which are frequently not shed, the sheaths of large specimens of *E. debile* are usually less than ½ in. (10 mm.) long while those of *E. ramosissimum* are fully 1 in. (25 mm.) in plants of corresponding size. The sheaths of large specimens of *E. ramosissimum* frequently turn brown with a papery texture. In this respect there is some similarity to *E. giganteum* and *E. myriochaetum.* All of the supposed *E. ramosissimum* of South America turned out to be small specimens of *E. giganteum* easily distinguished by its bands



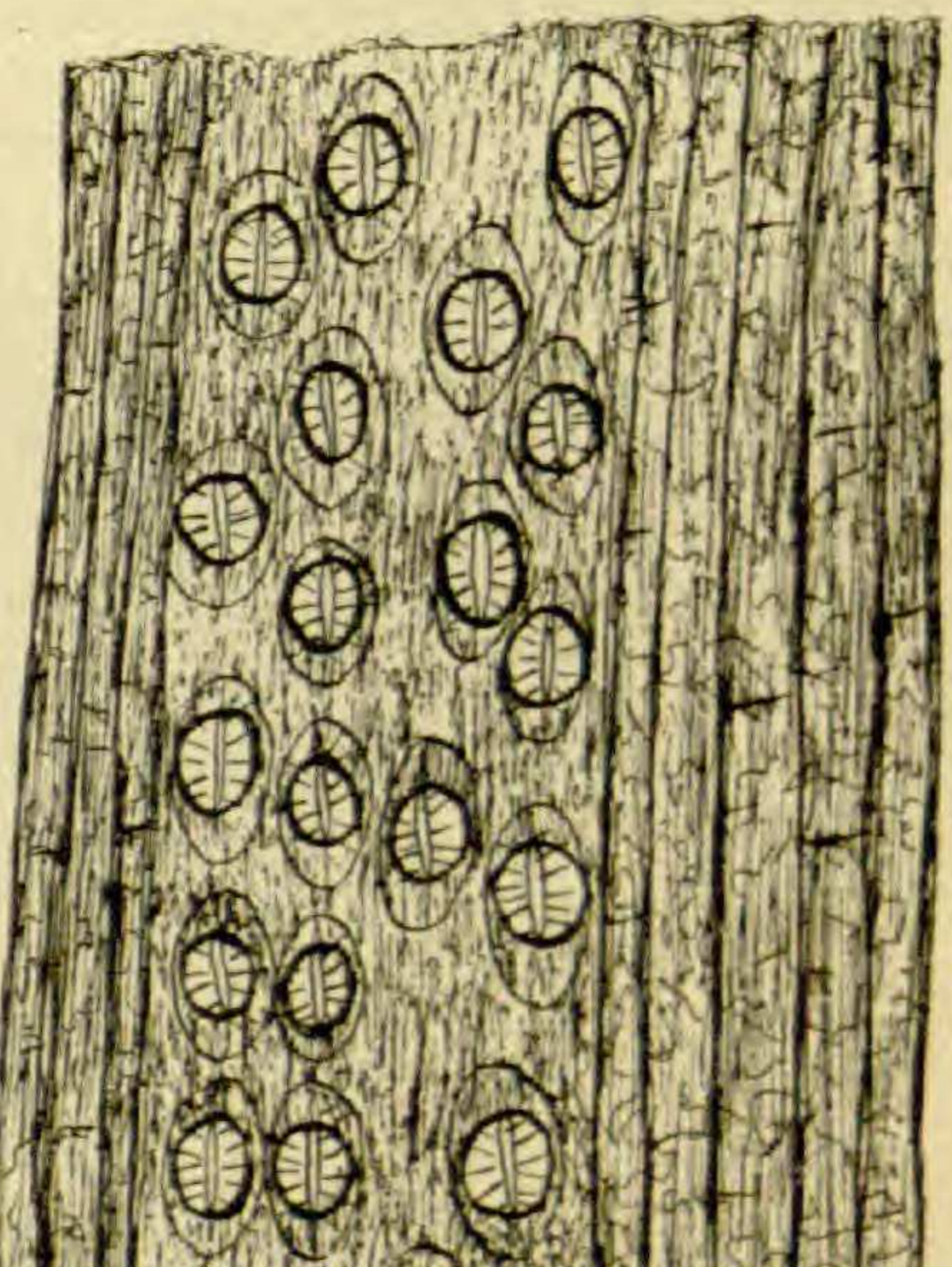
1

2

3



4



5

of stomata. In eastern and southern Mexico, improperly developed *E. laevigatum* or *E. myriochaetum* are sometimes referred to *E. ramosissimum*. Supposed specimens of *E. ramosissimum* from British Columbia turned out to be *E. trachyodon*. It is possible that *E. ramosissimum* is on the Pacific Coast of the United States, either native or introduced from Japan or China. It would be difficult to distinguish it from branched forms of *E. laevigatum*. Some specimens obtained from Mr. F. M. Cota from San Diego, California, appeared so similar to the smaller *E. ramosissimum* specimens of Europe and Asia that, had their origin not been known, they would have been determined as the latter species without any hesitation. This is a problem to be settled on the pacific coast. It appears to the writer that *E. debile* Roxb. is properly entitled to specific rank. Just because one cannot separate certain imperfect specimens is not to be taken as a criterion for the union of the two. One cannot easily separate young calves of horned and hornless cattle and those hybrids which have scurs in the mature condition, yet they represent three distinct hereditary types. *E. laevigatum* can be separated from *E. ramosissimum* as follows: It is much less branched and has more truncate, more ampliated, and more persistently green sheaths. The sheath segments of *E. laevigatum* have a central ridge and the same is usually true for *E. ramosissimum* but the latter may also have a central groove in the sheath segments of large sheaths or if a large shoot has developed from a broken stem.

EQUISETUM MYRIOCHAETUM SCHL. & CHAM.

Baker included *E. myriochaetum* with *E. giganteum* and also stated that *E. xylochaetum* was closely allied to *E. giganteum*. But *E. myriochaetum* has a very characteristic feature in that the stomata on the main stem

are in lines (Fig. 4), as in the typical EQUISETA HIBERNA while *E. giganteum* and *E. xylochaetum* have the stomata in bands commonly composed of three to five lines each (Fig. 5). *E. myriochaetum* sometimes has double lines of stomata for some distance and the same is true for large specimens of *E. ramosissimum* which must be regarded as the next higher species in the general series.

E. myriochaetum occurs in southern Mexico and occasionally in Central America and northern South America. Among other characteristic differences, *E. xylochaetum* has flat sheath segments and rigid, black, linear teeth which give out a twanging sound when picked while *E. giganteum* has much more membranous teeth and its sheath segments have a definite central ridge. Baker was right in disregarding *E. schaffneri*, *E. pyramidale*, and *E. martii*. They appear to be mere fluctuations of *E. giganteum* and *E. xylochaetum*. One could describe a large number of "species" in Equisetum based on such superficial characters as are supposed to be characteristic of these three "species."

The sheath of *E. myriochaetum* is very truncate, green in its earlier stages, nearly cylindrical, shorter than wide, with readily deciduous teeth and with sheath segments that are 3-keeled in the lower part or sometimes nearly to the top. The lines of stomata are very prominent and the large stem is usually nearly smooth, barely showing ridges. This species is then the proper connecting link between *E. giganteum* on the one hand and *E. ramosissimum* and *E. laevigatum* on the other. The ranges of *E. myriochaetum* and *E. laevigatum* come together in southern Mexico.

EQUISETUM MOOREI NEWM.

At various times a form of Equisetum intermediate in character between *E. ramosissimum* and *E. hiemale*

has been described from western Europe. *E. ramosissimum* is rather sensitive to frost but does frequently survive to the second year. It is not to be considered as an annual, however. The writer has seen large *E. ramosissimum* specimens which had endured the winter successfully, only the upper end being dead. The intermediate plant leading over to *E. hiemale* is about equally resistant to cold or more so. This plant is to be recognized as a proper species with the name *E. moorei* Newm. Edward Newman described *E. moorei* as a species in 1854.[1] The description given is as follows:

"*Rhizome* not noticed.

Stems annual, completely *deciduous,* 20–30 inches in length, 3 or 4 united at base, perfectly erect, always unbranched, acuminate, gradually tapering throughout their length, with 12 (more or less) deep, well-marked striae; the surface rough and hard to the touch; divided by transverse septa into 12 (more or less) internodes, the middle ones of which are longer than those of either extremity.

Sheaths loose, striated like the stem, the interspaces between the striae having a deep central sulcus, of a beautiful pearly white, with a black ring at the base, and black tips to the teeth; the sheaths of the spike black, spreading, campanulate, its teeth long, acuminate, aristate.

Teeth rigid, harsh, rounded or truncate at the apex, each having a median furrow on the back, the continuation of the intermediate furrows of the sheath; surmounted by loose, flaccid, membranous, silky, elongated, pointed awns, which are usually whitish, but occasionally black towards the apex of the stem; on the lower sheaths these awns appear evanescent, from their extreme fragility.

Spike sessile, black, composed of 35 (more or less) black, roundish scales, on which the striation of the stem

[1] The Phytologist for 1854 (Vol. V), p. 19.

is distinctly continued; surmounted by a solid, conical, acuminate apex.

Hab. Clay-banks facing the sea at Rockfield, County Wicklow, Ireland; found by Mr. Moore in company with Professor Melville, of Queens College, Galway.

Herb. Moore, Newman, etc."

While this description is taken up mostly with minute fluctuating details, as most of the earlier descriptions of species and varieties of Equisetum, there can be no question of the identity of the plant described. However, the plant does survive the winter, as intimated above, and it does branch, sometimes having cones on branches of the first year. New branches may also develop the second year. The sheaths described by Newman represent the extreme of discoloration due no doubt to the exposed habitat where the plants were collected. The sheaths in favorable habitats are long and ampliated and remain green for a long time.

The main characteristics of the species can thus be summarized as follows: Unbranched or sometimes branched either the first or second year; delicate perennial aerial shoots; long, green, ampliated sheaths usually with a black limb, becoming discolored in age; usually with promptly deciduous teeth; internodal ridges with an irregular double row of tubercles or cross hands of silex; sheath segments with a central groove; cones apiculate; often appearing superficially like *E. laevigatum*. Milde described this same type as a variety of *E. hiemale* in 1858, *E. hiemale schleicheri*. Hy described a similar plant from France in 1890 as *E. occidentale*, giving the name combination both as a variety and a species. In 1922 Samuelsson concluded that *E. hiemale schleicheri* is a hybrid between *E. hiemale* and *E. ramosissimum*. There is, however, no definite evidence for hybridity according to modern Mendelian principles of

heredity. The synonymy of the species is, therefore, as follows:

EQUISETUM MOOREI Newm. 1854.
E. hiemale schleicheri Milde. 1858.
E. occidentale Hy. 1890.
E. hiemale x *ramosissimum* Samuelsson. 1922.

These all refer to a common species representing the transition step between *E. ramosissimum* and *E. hiemale* and corresponding to the American *E. laevigatum* which stands between *E. ramosissimum* and *E. praealtum*. The plant has had other earlier designations in herbaria and perhaps other earlier published names. But as the older descriptions are too vague and incomplete it is not proper to resurrect any of them since they could never be properly established.

There is no evidence for the presence of *E. moorei* in America. Specimens so reported are to be referred to *E. laevigatum* which is easily distinguished from *E. moorei*. Unfortunately I was not able to find Newman's type specimen from Rockfield. But there is a fairly good specimen, in the herbarium of the Natural History Museum in South Kensington, collected by R. W. Scully in 1889. Another specimen from Rockfield, County Wicklow, collected in May, 1909, had only last years' shoots with about a foot of green stem and dead at the top. *E. moorei* can be separated readily from *E. hiemale* by its elongated ampliated sheaths and delicate winter habit. Its irregular double row of tubercles on the internodal ridges and its grooved sheath segments will distinguish it from both *E. ramosissimum* and *E. laevigatum* which have single rows of tubercles on the ridges and sheath segments usually with a central ridge.

EQUISETUM TRACHYODON A. BR.

Equisetum trachyodon was described by Alexander Braun in 1839. In recent years it has usually been

regarded as a hybrid between *E. hiemale* and *E. variegatum* because the cones are frequently semi-sterile. *E. hiemale doellii* Milde belongs to the same alliance, so if a well-developed plant was found it was usually regarded as *E. hiemale doellii.* This form is then simply the larger more perfectly developed *E. trachyodon.* In southwestern Greenland *E. trachyodon* occurs near one of the old Norsemen farms. Dr. C. H. Ostenfeld of Copenhagen kindly sent me enough of the Greenland material to make a definite determination. It may have been brought in by the Norsemen with hay from Iceland or Norway and then perpetuated itself in the locality ever since. It was reported as *E. hiemale doellii,* probably because one of the supposed parents of *E. trachyodon,* namely *E. hiemale,* has never been discovered in Greenland. The Greenland specimens, as judged by the sheaths and internodes, are typical *E. trachyodon.* The presence of sterile or semi-sterile cones in Equisetum is no criterion for determining hybridity. These semi-sterile and sterile cones occur in all species of Equisetum and in some species they are very abundant where no possibility of recent hybridization exists in the region. They occur with normal fertile shoots coming from the same rhizome. In the herbaria some species going under the name of *E. paleaceum* Doell. are extreme forms of *E. trachyodon* in the broad sense. *E. mackaii* Newm. is also a form of *E. trachyodon.*

The American plant described as *E. variegatum jesupi* by A. A. Eaton in 1904 is again only a form of *E. trachyodon.* Its general resemblance to *E hiemale* induced Farwell, in 1916, to rename it *Hippochaete hiemalis jesupi* and Marie-Victorin, in 1924, gave it the same position under the name *Equisetum hyemale jesupi. E. variegatum alaskanum* A. A. Eat., however, belongs to the *E. variegatum* alliance and not to *E.*

trachyodon, having a campanulate sheath, and long rigid black teeth with narrow margins. The typical *E. variegatum* is usually much more slender than its var. *alaskanum* and the teeth have a much broader white membranous margin. *E. variegatum* is thus for the most part easily separated from *E. trachyodon*.

The EQUISETA PUSILLA are not to be derived directly from either *E. moorei* or *E. hiemale* but must also be derived independently from the *E. ramosissimum—E. laevigatum* complex from ancestors with simple rows of tubercles and cross bands on the internodal ridges. This more primitive condition is retained in *E. nelsoni* (A. A. Eat.) Schaffn. but it has advanced otherwise to a nearly annual condition of the aerial shoots. The other three species of the EQUISETA PUSILLA have advanced decidedly in doubling the internodal ridges, culminating in the extreme type in *E. scirpoides*. *E. trachyodon* is thus represented centrally by what has been called *E. hiemale doellii* Milde and grades off on the one hand into the plant that has passed for a long time as the true *E. trachyodon* and on the other into Eaton's *E. variegatum jesupi*. Not all the specimens, however, labeled *E. hiemale doellii* in the herbaria are *E. trachyodon*. Some are simply small specimens of the true *E. hiemale*. As stated above *E. trachyodon* as now delimited is not to be derived from *E. hiemale* which shows a number of decided specializations of its own, among which are distinct abscission of the teeth and details of the sheath segments. *E. trachyodon* is intermediate in size between *E. hiemale* and *E. variegatum*. The sheaths are cylindrical, mostly all black or with a wide black band at the top. They are usually very crustaceous and the thickening does not extend very far into the short, narrow, mostly persistent teeth. They have a truncate appearance even when the teeth are not

broken off. This character increases its resemblance to *E. hiemale.*

With the recognition of *E. moorei, E. trachyodon, E. debile*, and *E. myriochaetum* as good species the total number of Equisetum species now considered valid by the writer amounts to 23.

THE SPECIMENS OF EQUISETUM IN LINNAEUS' HERBARIUM.

While in London, the opportunity was taken to examine the specimens of Equisetum in the Linnean Herbarium, possessed by the Linnean Society of London, at Burlington House, Piccadilly. The sheets are as follows and are without any data in general except the name: Genus 1241, Equisetum.

1. *E. silvaticum* (Sheets 1 and 2). The fertile shoot has no spicules on the internodal ridges of the main stem; the sterile shoot has double rows of spicules on the internodal ridges of the main stem.
2. *E. arvense* (Sheets 3 and 4). Fertile and sterile shoots.
3. *E. palustre* (Sheet 5).
4. *E. limosum* (Sheet 6). Contains unbranched shoots and a young branched shoot.
5. *E. hyemale* (Sheet 7).

Sheet 8 is a specimen of *E. variegatum* and has a label reading: Equisetum var: *latourrelle*—Tourelle. In lead pencil on the species sheet is written by someone

E. asperrimum Dick.
E. variegatum Jacq.

The word Tourelle in Linnaeus' handwriting probably refers to the locality from which the specimen came. Linnaeus' specimens are thus seen to be in a very unsatisfactory condition for critical study. Linnaeus was acquainted with six species of Equisetum, Five European species and one American species, *E. giganteum,*

although this is not in his herbarium. He evidently regarded *E. variegatum* as a form or variety of *E. hiemale.* The un-branched forms of *E. fluviatile* he called *E. limosum,* but since *E. fluviatile* is first on the list and both names have a continuous historical development the water horsetail should always bear the latter name. Linnaeus named the branched form *E. fluviatile* and the branched form is usually predominantly the common form while the naked form is a much rarer fluctuation. Pollich as early as 1777 selected *fluviatile* in preference to *limosum.*

EXPLANATION OF PLATE

FIG. 1. *Equisetum ramosissium* Desf. Typical sheath with teeth still persistent. Natural size.

FIG. 2. *Equisetum debile* Roxb. Typical sheath with teeth still persistent. Natural size.

FIG. 3. *Equisetum ramosissium* Desf. Sheath from small plant, the teeth fallen off. Natural size.

FIG. 4. *Equisetum myriochaetum* Cham. & Schlecht. Surface view of small area of main stem showing the single lines of stomata. Magnified about ×115.

FIG. 5. *Equisetum giganteum* L. Surface view of small area of main stem showing one of the bands of stomata composed of several lines. Magnified about ×115.